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Cephalometric evaluation of skeletal stability and pharyngeal airway changes after mandibular setback surgery: Bioabsorbable versus titanium plate and screw fixation

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ABSTRACT

Purpose: This study compared sequential changes in skeletal stability and the pharyngeal airway following mandibular setback surgery involving fixation with either a titanium or a bioabsorbable plate and screws.
Materials and Methods: Twenty-eight patients with mandibular prognathism undergoing bilateral sagittal split osteotomy by titanium or bioabsorbable fixation were randomly selected in this study. Lateral cephalometric analysis was conducted preoperatively and at 1 week, 3-6 months, and 1 year postoperatively. Mandibular stability was assessed by examining horizontal (BX), vertical (BY), and angular measurements including the sella-nasion to point B angle and the mandibular plane angle (MPA). Pharyngeal airway changes were evaluated by analyzing the nasopharynx, uvula-pharynx, tongue-pharynx, and epiglottis-pharynx (EOP) distances. Mandibular and pharyngeal airway changes were examined sequentially. To evaluate postoperative changes within groups, the Wilcoxon signed-rank test was employed, while the Mann-Whitney *U* test was used for between-group comparisons. Immediate postoperative changes in the airway were correlated to surgical movements using the Spearman rank test.
Results: Significant changes in the MPA were observed in both the titanium and bioabsorbable groups at 3-6 months post-surgery, with significance persisting in the bioabsorbable group at 1 year postoperatively ($2.29° \pm 2.28°$; $P < 0.05$). The bioabsorbable group also exhibited significant EOP changes (-1.21 ± 1.54 mm; $P < 0.05$) at 3-6 months, which gradually returned to non-significant levels by 1 year postoperatively.
Conclusion: Osteofixation using bioabsorbable plates and screws is comparable to that achieved with titanium in long-term skeletal stability and maintaining pharyngeal airway dimensions. However, a tendency for relapse exists, especially regarding the MPA. ***(Imaging Sci Dent 2024; 54: 181-90)***

KEY WORDS: Titanium; Biocompatible Materials; Prognathism; Orthognathic Surgery; Parapharyngeal Space; Cephalometry

Introduction

In the field of oral and maxillofacial surgery, the titanium osteofixation system is highly recommended due to its stable outcomes. Nevertheless, it presents potential drawbacks, including screw or plate migration, growth restriction, radiographic interference, image distortion in subsequent scans, and the occasional necessity for removal due to physiological or psychological factors.[1,2] To address these issues, plates and screws made from biologically inert and resorbable materials have been developed for bone fixation.

Bioresorbable materials offer a clinical advantage over metallic-based materials by eliminating the potential need for a second surgical procedure to remove them.[3] Furthermore, they demonstrate a reduced stress-shielding effect, avoid metal corrosion, and do not interfere with radiological assessments due to their radiolucent properties. These substances can also be easily bent with forceps at room temperature, and they preserve ongoing skeletal growth.[4] However, the primary concern for surgeons is the level of postoperative skeletal stability that can be achieved with resorbable plates and screws.

Mandibular setback surgery presents a range of chal-

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lenges, particularly regarding the intricacies of the surgical technique and the potential postoperative outcomes. The success of surgery is influenced by several factors, including the type of fixation used, the extent of mandibular segment rotation, and the risk of improper posterior positioning of the distal segment.[5] Additionally, the functional imbalance of the surrounding oropharyngeal complex following mandibular setback is thought to affect postoperative skeletal stability.[6] Changes in the skeletal structure resulting from mandibular setback surgery can also impact the airway. Notably, certain anatomical structures, such as the soft palate, the posterior border of the tongue, and the epiglottis, play a crucial role in maintaining the dimensions of the pharyngeal airway.[7]

Pharyngeal airway changes following mandibular setback surgery are critical to assess during the follow-up period, as substantial reduction may predispose individuals to postoperative sleep-disordered breathing conditions, such as obstructive sleep apnea or hypopnea. Previous studies have reported a significant reduction in the pharyngeal airway in individuals with mandibular prognathism after undergoing mandibular setback surgery, with this reduction sustained over the long term.[8]

Various methods are employed to evaluate skeletal stability after orthognathic surgery, including clinical examination, dental cast analysis, lateral cephalometric analysis, and 3-dimensional cone-beam computed tomography imaging.[6] Of these, the 2-dimensional cephalogram is essential, offering a reliable and cost-effective means of assessing both hard and soft tissue structures in the craniofacial region.[7,8]

Several cephalometric studies have compared the mandibular stability achieved with the same osteofixation techniques between titanium and resorbable materials[9,10] or different material designs.[11] However, to these authors' knowledge, no study has yet compared titanium and resorbable osteofixation with regard to skeletal stability and pharyngeal airway changes following mandibular setback surgery. Consequently, this study aimed to compare cephalometric outcomes in terms of the skeletal stability of the mandible and associated changes in the airway after fixation with bioabsorbable plates and screws versus the gold standard, titanium.

Materials and Methods

This retrospective cohort study was conducted at the Faculty of Dentistry, Chulalongkorn University, Bangkok, Thailand. The Human Research Ethics Committee of the Faculty reviewed and approved the research protocol (HREC-DCU 2021-026). A total of 28 participants who were diagnosed with skeletal class III malocclusion and had undergone mandibular setback surgery between December 2015 and November 2020 were identified from the university database. The inclusion criteria encompassed a diagnosis of mandibular prognathism with or without facial asymmetry, being over 18 years old at the time of surgery, and having both preoperative and postoperative lateral cephalograms available. Patients were excluded if they presented with craniofacial syndromes such as cleft lip and palate, hemifacial microsomia, Goldenhar syndrome, Crouzon syndrome, or Treacher Collins syndrome; had a history of previous maxillofacial trauma; or had undergone additional procedures such as bimaxillary surgery, Le Fort I osteotomy, or genioplasty.

Before surgery, all participants underwent orthodontic treatment for an average duration of 6 months. A single Thai board-certified oral and maxillofacial surgeon performed all procedures, employing a consistent surgical technique under general anesthesia within strict aseptic conditions. The bilateral sagittal split osteotomy (BSSRO) technique was used for setback, incorporating the modified Epker approach and complete stripping of the pterygomasseteric sling. The osteotomy involved 3 incisions: a horizontal cut made above the lingula, a vertical cut through the buccal cortex of the first mandibular molar, and a sagittal cut along the mandibular body that connected the previous 2 cuts. The proximal and distal segments of the mandible were secured in the predetermined position using a miniplate with 4 holes as well as 4 monocortical screws on each side of the mandible. In the resorbable group, bone fixation following BSSRO was achieved using a resorbable plate system, whereas a titanium plate system was utilized in the titanium group. Postoperatively, all patients were placed in maxillomandibular fixation for 2 weeks.

Lateral cephalometric radiographs were taken at 4 different time points: before surgery (T0), within 1 week after surgery (T1), between 3 to 6 months post-surgery (T2), and 1 year following surgery (T3). These images were captured using a Kodak 9000C Digital panoramic and cephalometric system (Carestream, Rochester, NY, USA) following a standardized protocol (82 kVp, 10 mA, and 3.2 seconds). During the scanning process, patients were instructed to stand upright, face forward, and maintain a natural head position using the head clamps of the cephalostat. The patients were asked to relax their lips, keep their teeth in centric occlusion, and remain still without swallowing during the radiographic exposure.

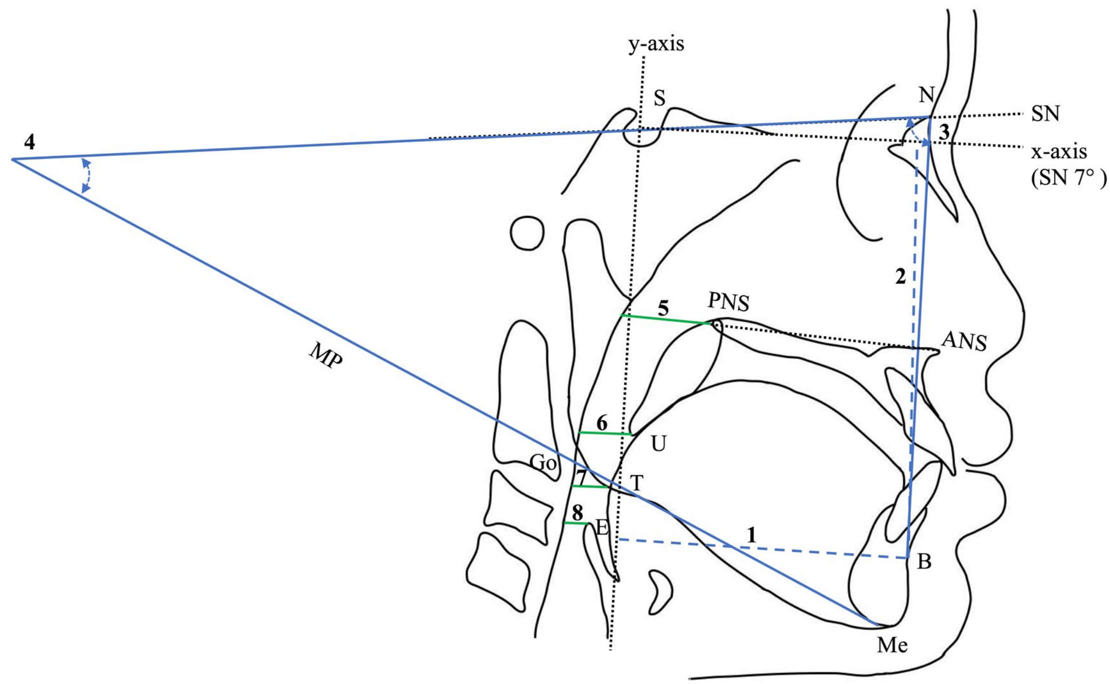

Fig. 1. Landmarks, reference lines, and measurement parameters used in this cephalometric analysis. S: sella, N: nasion, B: point B, Me: menton, Go: gonion, ANS: anterior nasal spine, PNS: posterior nasal spine, U: tip of the uvula, T: posterior tongue, E: tip of the epiglottis, SN: line connecting points S and N, MP: line connecting points Go and Me, 1 (BX): horizontal perpendicular line to the y-axis from point B, 2 (BY): vertical perpendicular line to the x-axis from point B, 3 (SNB): angle formed by the SN line and a line drawn through points N and B, 4 (MPA): angle between the SN line and the MP line, 5 (NOP): distance from PNS to the pharyngeal wall along the ANS-PNS plane, 6 (UOP): distance from U to the pharyngeal wall perpendicular to the y-axis, 7 (TOP): the shortest distance between T and the pharyngeal wall perpendicular to the y-axis, 8 (EOP): distance from E to the pharyngeal wall perpendicular to the y-axis.

Conventional manual tracing was conducted by a single investigator (P.T., a postgraduate student in the Department of Oral and Maxillofacial Surgery), who received training and calibration from an experienced professional. For the tracing, an acetate paper (0.003 inches thick; G&H Orthodontics, Franklin, IN, USA) was fitted onto each cephalometric film. The tracing was performed by hand in a dimly lit room using a lightbox and a 0.5-mm 2B lead mechanical pencil. When tracing double images or bilateral structures, the midpoint was used as the reference. Linear and angular measurements were taken with a millimeter ruler and a protractor, accurate to the nearest 0.5 mm and 0.5°, respectively.

Ten anatomical landmarks and 6 reference lines were traced on the lateral cephalometric radiograph. Eight measurement parameters were established for this study (Fig. 1). To assess postoperative sagittal changes, a horizontal reference line (x-axis) was created by rotating the sella-nasion line approximately 7° in the clockwise direction. A vertical reference line (the y-axis) was then drawn perpendicular to the x-axis at the sella. Skeletal stability was evaluated by measuring the perpendicular distance from point B to the y-axis (BX) and to the x-axis (BY). The angular measurements included the sella-nasion to point B (SNB) angle and the mandibular plane angle (MPA). For pharyngeal airway assessment, horizontal measurements of the airway were taken at 4 levels: nasopharynx (NOP), uvula-pharynx (UOP), tongue-pharynx (TOP), and epiglottis-pharynx (EOP). The NOP was measured as the extension of the anterior nasal spine-posterior nasal spine plane to the posterior pharyngeal wall. The UOP, TOP, and EOP measurements were taken from specific landmarks relative to the posterior pharyngeal airway space, using a perpendicular approach to the y-axis.

Changes in measurements were categorized as follows: immediate postoperative changes (T1-T0), short-term stability (T2-T1), and long-term stability (T3-T1). A negative value signifies that the post-surgical measurement shifted backward or upward. All measurements - BX, BY, SNB, MPA, NOP, UOP, TOP, and EOP - were compared at the immediate postoperative, short-term stability, and long-term stability stages between the titanium and bioabsorb-

Table 1. Patient characteristics including age, sex, amount of setback, and initial parameters for the titanium and resorbable groups

		Titanium group (n = 14)	Resorbable group (n = 14)	*P*-value
Age (years)		26.79 ± 4.17	25.29 ± 4.08	0.369[a]
Sex (male/female)		4/10	3/11	1.000[b]
Amount of setback (mm)		6.61 ± 3.97	5.36 ± 3.26	0.357[a]
Skeletal parameters	BX (mm)	73.00 ± 7.25	68.82 ± 8.79	0.260[a]
	BY (mm)	91.57 ± 5.85	92.61 ± 6.33	0.549[a]
	SNB (°)	86.93 ± 3.48	84.50 ± 3.99	0.127[a]
	MPA (°)	33.07 ± 5.17	36.64 ± 5.96	0.093[a]
Airway parameters	NOP (mm)	24.14 ± 3.83	23.79 ± 3.49	0.817[a]
	UOP (mm)	11.46 ± 2.55	9.82 ± 1.78	0.058[a]
	TOP (mm)	12.96 ± 3.68	11.14 ± 3.98	0.127[a]
	EOP (mm)	7.71 ± 2.68	7.43 ± 2.54	1.000[a]

BX: horizontal perpendicular line from point B to the y-axis, BY: vertical perpendicular line from point B to the x-axis, SNB: sella-nasion to point B angle, MPA: mandibular plane angle, NOP: nasopharyngeal airway, UOP: uvula-pharyngeal airway, TOP: tongue-pharyngeal airway, EOP: epiglottis-pharyngeal airway, [a]Mann-Whitney *U* test, [b]Fisher exact test.

able groups.

The reproducibility of the measurements was evaluated by randomly selecting 40 lateral cephalometric radiographs. Each parameter was retraced and remeasured by the same examiner 10 days after the initial measurement. Furthermore, calibration was conducted between the expert and the non-expert examiner.

All data were analyzed using SPSS version 26.0 (IBM Corp, Armonk, NY, USA). The normality of the data distribution was assessed with the Shapiro-Wilk test. The Mann-Whitney *U* test was employed to compare age, the amount of mandibular setback, preoperative measurements, and postoperative surgical differences in all parameters between the titanium and resorbable groups. The Fisher exact test was utilized to determine the association between sex and the type of osteofixation used. To analyze immediate postoperative changes, short-term stability, and long-term stability within each group, the Wilcoxon signed-rank test was applied. Spearman correlation coefficients were used to evaluate the relationship between pharyngeal airway changes and surgical skeletal repositioning. For all statistical analyses, a *P*-value of less than 0.05 was considered to indicate statistical significance. Intraclass correlation coefficients (ICCs) were utilized to assess intra- and inter-examiner variance.

Results

A total of 28 patients, 7 male and 21 female, were enrolled in this study. The basic information of these patients is summarized in Table 1. The mean duration of T2 was 4.5 ± 1.45 months in the resorbable group and 4.36 ± 1.39 months in the titanium group. T3 had a mean duration of 17.29 ± 6.83 months in the resorbable group and 18.57 ± 6.35 months in the titanium group.

The ICCs for intraobserver agreement on skeletal and pharyngeal airway parameters ranged from 0.905 to 0.994. For interobserver agreement, the ICCs were between 0.89 and 0.94. Both sets of ICC results indicated excellent reliability of the measurements in this study. The demographic data, which included age, the amount of setback, and sex, are presented in Table 1. These data revealed no statistically significant differences between the 2 groups being compared. At the pre-surgical stage (T0), no significant differences were found in any of the parameters, skeletal or pharyngeal, between the groups.

After mandibular setback surgery, significant posterior movement was observed for BX in both groups at the immediate postoperative time point (T1-T0). When comparing preoperative (T0) and immediate postoperative (T1) measurements, the decrease in the value of BY in the titanium group was statistically significant. However, in the resorbable group, the decrease in BY was not significant. Regarding angular changes, the SNB angle significantly decreased in both groups ($P < 0.05$), but no statistically significant changes were noted in the MPA. As for pharyngeal airway changes, reductions were seen in the NOP and TOP in both groups. Nevertheless, none of the pharyngeal airway parameters showed significant differences (Table 2).

Table 2. Comparison of immediate postoperative changes (T1-T0) in the titanium and resorbable groups

		Titanium group (n = 14)		Resorbable group (n = 14)		P-value[b]
		Diff	P-value[a]	Diff	P-value[a]	
Skeletal parameters	BX (mm)	−6.61 ± 3.97	<0.05	−5.36 ± 3.26	<0.05	0.357
	BY (mm)	−1.46 ± 2.01	<0.05	−0.12 ± 2.41	0.893	0.061
	SNB (°)	−4.00 ± 2.38	<0.05	−2.87 ± 2.77	<0.05	0.300
	MPA (°)	−0.14 ± 1.96	0.832	0.47 ± 1.84	0.246	0.258
Airway parameters	NOP (mm)	0.04 ± 2.03	0.719	0.11 ± 3.13	0.725	0.459
	UOP (mm)	−0.96 ± 2.84	0.132	0.14 ± 2.57	0.972	0.321
	TOP (mm)	−1.36 ± 3.21	0.157	−1.11 ± 2.82	0.171	0.782
	EOP (mm)	0.07 ± 3.59	0.779	0.04 ± 1.46	1.000	0.782

The mark "–" indicates movement to left (posterior) or upward. T0: preoperative, T1: 1 week post-surgery, BX: horizontal perpendicular line from point B to the y-axis, BY: vertical perpendicular line from point B to the x-axis, SNB: sella-nasion to point B angle, MPA: mandibular plane angle, NOP: nasopharyngeal airway, UOP: uvula-pharyngeal airway, TOP: tongue-pharyngeal airway, EOP: epiglottis-pharyngeal airway, Diff: difference in the parameter between T1 and T0, [a]Wilcoxon signed-rank test, [b]Mann-Whitney *U* test

Table 3. Comparison of short-term stability (T2-T1) in the titanium and resorbable groups

		Titanium group (n = 14)		Resorbable group (n = 14)		P-value[b]
		Diff	P-value[a]	Diff	P-value[a]	
Skeletal parameters	BX (mm)	0.79 ± 1.46	0.073	1.18 ± 1.50	<0.05	0.547
	BY (mm)	−0.79 ± 2.41	0.262	−0.29 ± 2.81	0.694	0.695
	SNB (°)	0.64 ± 0.97	<0.05	0.62 ± 1.50	0.123	0.577
	MPA (°)	0.86 ± 1.43	<0.05	2.09 ± 2.14	<0.05	0.139
Airway parameters	NOP (mm)	0.29 ± 1.49	0.473	−0.61 ± 1.86	0.243	0.340
	UOP (mm)	−0.29 ± 3.40	0.806	−1.16 ± 2.20	0.073	0.369
	TOP (mm)	0.04 ± 2.94	0.680	−0.39 ± 2.09	0.504	0.430
	EOP (mm)	−0.89 ± 3.55	0.642	−1.21 ± 1.54	<0.05	0.102

The mark "–" indicates movement to the left (posterior) or upward. T1: 1 week post-surgery, T2: 3-6 months post-surgery, BX: horizontal perpendicular line from point B to the y-axis, BY: vertical perpendicular line from point B to the x-axis, SNB: sella-nasion to point B angle, MPA: mandibular plane angle, NOP: nasopharyngeal airway, UOP: uvula-pharyngeal airway, TOP: tongue-pharyngeal airway, EOP: epiglottis-pharyngeal airway, Diff: difference in the parameter between T2 and T1, [a]Wilcoxon signed-rank test, [b]Mann-Whitney *U* test.

For short-term stability (T2-T1), the BX position moved anteriorly in the horizontal plane for both groups; however, a statistically significant change was observed only in the resorbable group. A vertical reduction in BY was also noted for both groups, but these changes did not reach statistical significance. In terms of angular changes, the titanium group exhibited significant differences in the SNB angle. Additionally, the MPA displayed significant differences in both groups. All pharyngeal parameters shifted horizontally, but the only statistically significant finding was a reduction in EOP within the resorbable group (Table 3).

Significant changes were only observed in the long-term stability (T3-T1) for BX in the titanium group and in the angular measurements. The SNB angle increased in the titanium group, whereas the MPA widened in the resorbable group. No statistically significant changes were detected in other parameters, including linear changes in BY and alterations in the pharyngeal airway space (Table 4). At 1 year following the mandibular setback procedure, no significant changes in the pharyngeal airway were noted in either the titanium or resorbable groups.

As indicated in Table 5, Spearman correlation analysis of immediate postoperative changes (T1-T0) revealed that none of the pharyngeal airway space measurements (NOP, UOP, or TOP) for either group exhibited a significant correlation with any skeletal changes (BX, BY, SNB, or MPA). However, EOP demonstrated a moderate and significant correlation with the MPA in the titanium group ($r = 0.568$,

Table 4. Comparison of long-term stability (T3-T1) in the titanium and resorbable groups

		Titanium group (n=14)		Resorbable group (n=14)		P-value[b]
		Diff	P-value[a]	Diff	P-value[a]	
Skeletal parameters	BX (mm)	1.26±1.77	<0.05	1.07±2.23	0.102	0.747
	BY (mm)	−0.98±1.99	0.083	−1.36±3.93	0.505	0.447
	SNB (°)	0.82±1.05	<0.05	0.62±1.72	0.192	0.594
	MPA (°)	0.25±1.11	0.407	2.29±2.28	<0.05	<0.05
Airway parameters	NOP (mm)	0.46±2.48	0.562	0.86±2.16	0.219	0.564
	UOP (mm)	−0.29±3.77	0.861	−1.04±2.16	0.097	0.392
	TOP (mm)	0.14±3.99	0.255	0.00±2.56	0.888	0.546
	EOP (mm)	−0.86±4.12	0.789	−0.32±2.31	0.753	0.695

The mark "–" indicates movement to the left (posterior) or upward. T1: 1 week post-surgery, T3: 1 year post-surgery, BX: horizontal perpendicular line from point B to the y-axis, BY: vertical perpendicular line from point B to the x-axis, SNB: sella-nasion to point B angle, MPA: mandibular plane angle, NOP: nasopharyngeal airway, UOP: uvula-pharyngeal airway, TOP: tongue-pharyngeal airway, EOP: epiglottis-pharyngeal airway, Diff: difference in the parameter between T3 and T1, [a]Wilcoxon signed-rank test, [b]Mann-Whitney U test.

Table 5. Correlation between skeletal and pharyngeal airway changes at the immediate postoperative time point (T1-T0)

		Titanium group (n=14)				Resorbable group (n=14)			
		NOP	UOP	TOP	EOP	NOP	UOP	TOP	EOP
BX	r	−0.020	−0.149	−0.384	−0.409	−0.347	0.176	0.273	0.545
	P-value	0.945	0.612	0.175	0.147	0.223	0.548	0.346	<0.05
BY	r	0.278	−0.304	0.093	0.468	0.016	−0.026	0.018	−0.036
	P-value	0.336	0.291	0.752	0.091	0.957	0.931	0.952	0.903
SNB	r	0.053	−0.174	−0.337	−0.354	−0.318	0.415	0.341	0.374
	P-value	0.858	0.552	0.238	0.214	0.268	0.140	0.233	0.187
MPA	r	0.135	0.038	0.335	0.568	0.272	−0.099	−0.025	0.063
	P-value	0.646	0.896	0.242	<0.05	0.348	0.735	0.934	0.831

T0: preoperative, T1: 1 week post-surgery, BX: horizontal perpendicular line from point B to the y-axis, BY: vertical perpendicular line from point B to the x-axis, SNB: sella-nasion to point B angle, MPA: mandibular plane angle, NOP: nasopharyngeal airway, UOP: uvula-pharyngeal airway, TOP: tongue-pharyngeal airway, EOP: epiglottis-pharyngeal airway, r: correlation coefficient. P-values were determined based on the Spearman correlation coefficient test.

$P<0.05$) and with BX in the resorbable group (r=0.545, $P<0.05$).

Discussion

Titanium plates and screws have long been considered the gold standard in oral and maxillofacial osteofixation procedures due to their demonstrated postoperative stability and good biocompatibility. Consequently, surgeons have frequently opted for these materials. However, resorbable plates offer clinical advantages over their metal counterparts, including the elimination of the need for secondary surgery—a particularly appealing option for patients undergoing orthognathic procedures. While numerous clinical studies have investigated the enhanced skeletal stability provided by resorbable plates and screws, none have previously addressed changes in the pharyngeal airway. This retrospective study underscores the stability of the resorbable osteofixation system in orthognathic surgery and suggests it as a reliable alternative to the titanium system, particularly for cases in which a secondary operation to remove the plate is especially undesirable.

The present study examined skeletal relapses in both horizontal and vertical dimensions, focusing on the B and menton reference points. Most of the observed skeletal relapses occurred within the first 3 to 6 months postoperatively. Notably, patients who underwent resorbable fixation exhibited significant anterior movement of point B from its post-surgical position. This indicates a pronounced tendency for horizontal relapse in the resorbable fixation group relative to titanium fixation, particularly during the short-term stability period. This trend may be partially attributed to the lower initial mechanical strength of the bioabsorbable material during the initial healing phase.[12]

Nonetheless, the titanium fixation group displayed considerable horizontal relapse within 1 year postoperatively. These results align with those reported in a previous study by Landes et al.,[9] in which a longer follow-up period, averaging 24±22 months, revealed a higher rate of relapse in patients with titanium fixation. Specifically, the relapse noted in that study affected both the horizontal dimension, especially at the B point, and the vertical dimension, as evidenced by changes in the gonial angle. Supporting the present findings, research by Park et al.[11] also showed less favorable long-term skeletal stability, particularly at the 2-year postoperative mark, in patients treated with titanium fixation compared to those with resorbable fixation.

Long-term stability analysis showed that changes in the SNB angle were minimal for both groups. The titanium group exhibited a mean change of 0.82°±1.05°, while the resorbable group had a slightly smaller mean change of 0.62°±1.72°. Rao et al.[13] found similar consistency in SNB angle changes (0.8°-1.2°) with titanium plate and screw fixation over a 1-year follow-up. Although skeletal changes were detectable on cephalometry, these were not clinically significant. Even with the use of plates and screws for rigid skeletal fixation, minor fragment movements can occur during bone remodeling. If these movements are not clinically significant, additional intervention is not warranted.

Park et al.[11] provided an interpretation of the changes in MPA observed 6 months after surgery. They suggested that these alterations stemmed from a combination of segmental remodeling, adaptive changes in the temporomandibular joints (the proximal segment), and postoperative orthodontics. In the present study, significant shifts in MPA were noted in both the titanium and resorbable fixation groups during the evaluation of short-term stability. However, when assessing long-term stability, a significant difference in MPA was evident only in the resorbable group. A previous study[10] indicated that resorbable fixation was less stable vertically than titanium over the long term. The present findings support this, suggesting that resorbable fixation may be less stable in the vertical dimension; this could lead to the development of an open bite over time more readily than with titanium fixation.

When planning to use resorbable plates and screws, it is advisable to consider a longer period of intermaxillary fixation and to use either double plates or a mesh design plate to maintain the stability of the bone segments.[9,11] To offer a more practical and cost-effective solution for preventing plate breakage during the early stages of osteosynthesis, Ueki et al.[14] suggested the bicortical plate fixation method following mandibular setback surgery. This technique involves the placement of a single miniplate with 2 bicortical screws on the proximal segment and 2 monocortical screws on the distal segment of the osteotomized mandible.

After mandibular setback surgery to correct mandibular prognathism, the anatomical structures at the base of the tongue that are attached to the mandible and are part of the upper airway are also repositioned. While this is expected to narrow the upper airway, the long-term stability of these airway changes has been a matter of debate. Enacar et al.[15] reported that a reduction in the hypopharyngeal airway following mandibular setback may be a lasting change. In contrast, a study by On et al.[16] found that the narrowing of the oropharynx recovered by 2.0 mm within 6 months after surgery. Additionally, Choi et al. reported that an approximate 11% reduction in airway space remained for up to 1 year after the operation. The partial recovery of the airway space could be attributed to the repositioning of the hyoid bone, which exhibited marked anterior and superior movement, although it never fully returned to its preoperative position.[17]

Previous studies have explored changes in the upper airway following orthognathic surgery, with a focus on those involving titanium fixation systems. However, our study was the first to examine upper airway modifications associated with resorbable and titanium fixations. Before surgery, no significant differences were noted between these 2 types of fixations in terms of various pharyngeal airway dimensions. Measurements of the NOP, UOP, and TOP revealed no significant changes in either the short-term or long-term stability periods according to the fixation type. However, the patients treated with resorbable fixation exhibited significant EOP changes at the short-term stability point, which occurred 3-6 months after surgery. These changes diminished over time and stabilized by 1 year postoperatively. This result aligns with findings from a previous study indicating that the reduction in airway space following mandibular setback surgery tended to recover during short-term follow-up, with improvements persisting at long-term assessments. Nonetheless, the reduction in airway space, particularly at the levels of the oropharynx and hypopharynx, did not fully recover until 1 year after surgery.[18]

Conflicting results have been published regarding the relationship between the extent of mandibular setback and the reduction in pharyngeal airway space. Previous research has indicated that the degree of mandibular setback significantly affects the narrowing of the pharyngeal airway.[17] However, other studies have found no significant correlation between the size of the pharyngeal airway space and the amount of mandibular setback.[7,16] In the present study, the mean mandibular setback was 6.61 ± 3.97 mm for the titanium group and 5.36 ± 3.26 mm for the resorbable group. Values in this range have been found to pose no clinical issues concerning skeletal stability or airway function. Notably, factors such as body mass index and natural head posture may also play a role in pharyngeal airway changes following surgery.[18]

Eppley[19] provided a comprehensive view into the practical application of resorbable plates and screws in orthognathic surgery, drawing on a decade of experience. Resorbable osteosynthesis has been shown to be effective in correcting typical dentofacial deformities with minimal bony discrepancies between the maxilla and mandible. Furthermore, Eppley noted that patients with conditions such as cleft or craniofacial deformities, a segmented maxilla, or maxillary or chin advancements greater than 5 mm, as well as those requiring mandibular advancements exceeding 15 mm, are not suitable candidates for resorbable fixation. Therefore, meticulous patient selection is crucial to promote the clinical success of resorbable fixation in orthognathic surgery.

The most noteworthy benefit of using bioabsorbable plates and screws is that they eliminate the need for patients to undergo a second surgery to remove the hardware. This advantage not only reduces patient discomfort and the risk of complications from another operation but also improves the overall efficiency of treatment. A case series that examined the use of bioresorbable plates for mandibular fracture fixation in children (mean age, 8.13 years) demonstrated sustained growth and the absence of facial asymmetry during a follow-up period of up to 54 months.[20] Despite these potential benefits, the adoption of resorbable fixation systems faces certain challenges. The cost of bioabsorbable systems generally exceeds that of traditional titanium alternatives, which limits their broader use.[21] Additionally, bioabsorbable fixation demands more complex techniques because the materials require heat adaptation and shaping to conform to the bone surface. Consequently, the increased complexity of the procedure requires additional time and meticulous attention to detail.

Postoperative infections have been a key concern when using resorbable plates and screws, with an observed infection rate of 16% within the first 1 to 2 months after surgery, particularly in the median portion of the mandible. This susceptibility is thought to arise from the thinness of the intraoral soft tissue in this area.[22] Additionally, the larger size of the resorbable plate and screw heads may create potential "dead spaces" that could harbor sources of infection. However, the present study revealed no clinical issues, such as signs of infection or wound discomfort, in patients who were treated with resorbable plates and screws during up to 33 months of follow-up. Furthermore, no evidence of foreign body reactions or dysfunction of the temporomandibular joint was observed throughout the entire follow-up period.

Mandibular relapse can be attributed to a variety of factors, which fall into 3 broad categories: surgical, patient-related, and orthodontic. Surgical factors include the magnitude and direction of skeletal movement, the proper seating of the condyles, and the type of osteofixation system used. Patient-related factors encompass sex, age (particularly in relation to remaining growth and remodeling potential), the pre-surgical skeletal pattern (for example, a high MPA combined with mandibular hypoplasia), soft tissue and muscle tension, and temporomandibular joint impairment. Orthodontic factors, such as pre- and post-surgical orthodontic alignment and changes in the occlusal plane, can also influence mandibular relapse.[23,24]

Previous studies have indicated that most relapses following mandibular setback surgery occur within the first year after the operation.[11,25] In 2005, De Villa et al.[26] investigated skeletal stability after mandibular setback surgery at 2 time points: before and 1 year after the procedure. The authors found that most long-term horizontal and vertical changes became evident within the first year following surgery. Consequently, the present study focused on this pivotal postoperative period, operating under the assumption that the stability observed over a more extended timeframe would likely remain consistent. However, future research could benefit from a longer follow-up period to more thoroughly assess late postoperative changes.

This retrospective study has several additional limitations. For instance, the pharyngeal airway was evaluated in 2 dimensions, whereas the actual airway is cylindrical, which means that volume changes could not be assessed. Another limitation is the lack of examination of the condylar position, which may affect the stability of the mandible after surgery. Additionally, the small sample size is a key shortcoming of this study. To overcome these limitations and achieve a more thorough understanding, future research should include a multidimensional assessment of the airway and a comprehensive evaluation of other risk factors that influence skeletal stability. This investigation should be conducted in a larger study population and over a longer observation period.

The use of resorbable plates and screws does not appear to have adversely impacted the long-term stability of the pharyngeal region after mandibular setback surgery, showing performance on par with the gold standard of titanium fixation. However, in terms of short-term stability, resorbable plates and screws were associated with greater skeletal horizontal changes compared to titanium, as well as larger alterations in the MPA. These findings suggest that while resorbable fixation demonstrates favorable clinical outcomes, patients treated with this method may require longer follow-up periods to confirm the persistence of their clinical progress.

Conflicts of Interest: None

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